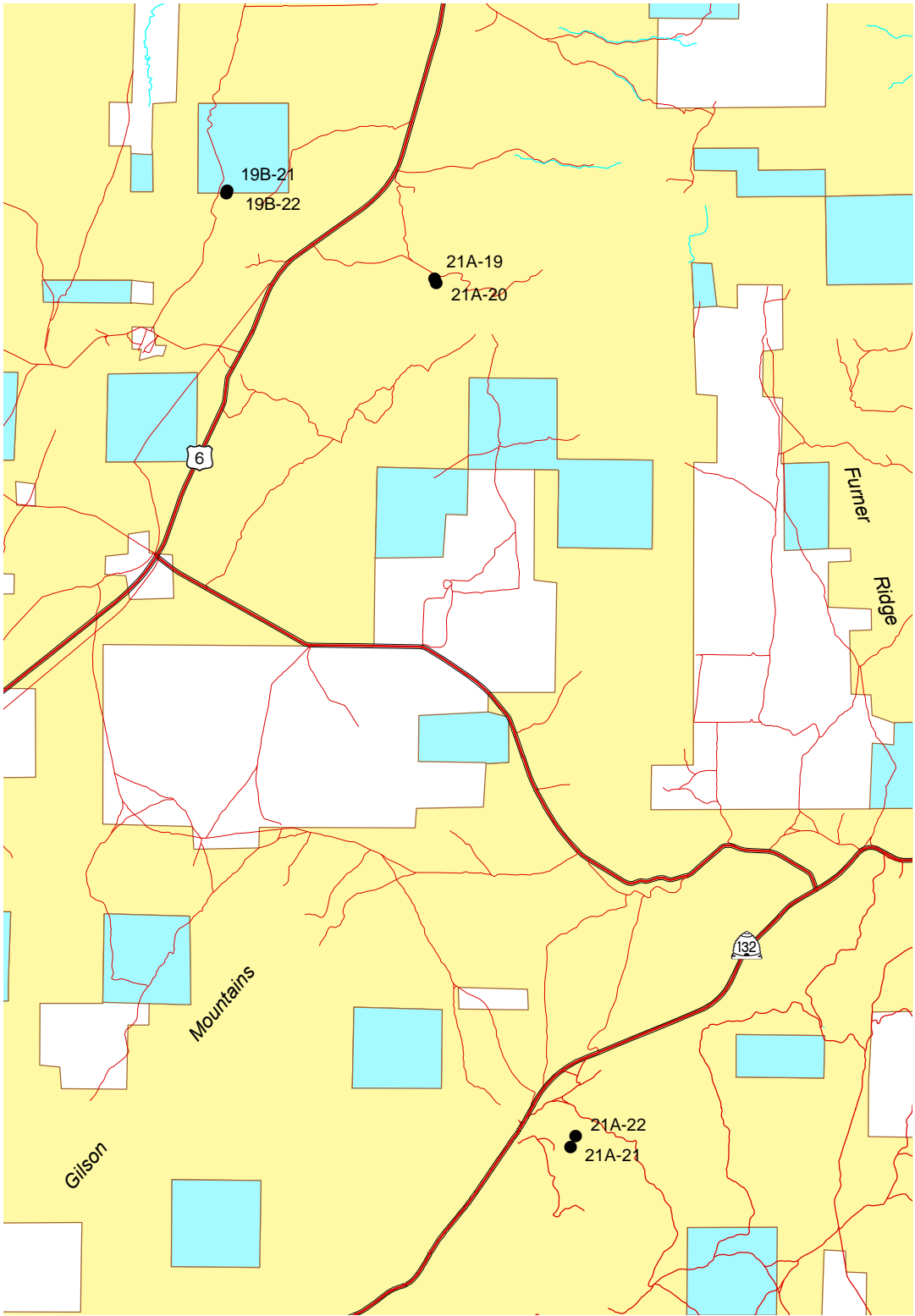


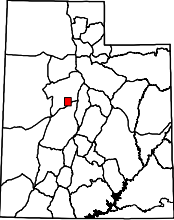
Burn Rehab Treatment Area



Map Scale 1:115,249 (1 inch = 1.8 miles)

Map Location

- BLM
- State of Utah
- Private Land
- Water Body
- Major Road
- Minor Road
- Water Course



LEAMINGTON BURN COMPLEX SPECIAL STUDIES

Introduction

In 1996, Utah experienced one of its most active, extensive, and devastating fire seasons in history. In Millard and Juab Counties alone, some 250,000 acres (101,171 ha) burned. The Leamington complex was the largest burned area, covering approximately 138,340 acres (55,984 ha) of mostly pinyon-juniper woodland. Rehabilitation efforts began in the fall of 1996, which included drilling the more accessible low-lying areas, with the remainder being aurally seeded and one-way chained to cover the seed. On the Leamington complex, about 6,100 acres (2,469 ha) were treated with a rangeland drill, 10,736 acres (4,345 ha) were aurally seeded and one-way chained, and 8,308 acres (3,362 ha) were aurally seeded only. Aurally seeding and then chaining is an effective method of breaking up burned trees, which provide valuable surface litter to help protect the soil from erosion. Chaining also enhances seed establishment by covering the seed with soil and litter. This practice was stopped temporarily because of concerns voiced by environmental and Native American groups with regard to archeological resources in the burned areas, even though an archeological survey had been completed. In 1997, two studies named Leamington Burn and Chain (21A-21) and Leamington Burn (21A-22) were established. One was placed in a burned and seeded area, and the other in an area that had been burned, seeded, then chained one-way. Additional pairs of studies were established in 1998; two near Jericho (19B-21 and 19B-22), and two near Paul Bunyan (21A-19 and 21A-20) to monitor the effects of treatments to those at the Leamington sites. The purpose of these studies was to monitor and compare the recovery of these areas following rehabilitation using seeding alone and seeding and chaining.

Seed Lists

Jericho State Section (19B-21)

Aerial Seed Mix

Species	Pounds per acre	Kg per ha
High Crest (<i>Agropyron cristatum</i>)	5	5.6
Intermediate Wheatgrass (<i>Agropyron intermedium</i>)	3	3.4
Alfalfa (<i>Medicago sativa</i>)	1	1.1
Yellow Sweet Clover (<i>Melilotus officinalis</i>)	0.5	0.6

Jericho BLM Section (19B-22)

Aerial Seed Mix

Species	Pounds per acre	Kg per ha
High Crest (<i>Agropyron cristatum</i>)	3.1	3.5
Rye (<i>Elymus junceus</i>)	2.1	2.4
Tall wheatgrass (<i>Agropyron elongatum</i>)	2.0	2.3
Smooth Brome (<i>Bromus inermis</i>)	1.9	2.1

Dribbler Seed Mix

Fourwing saltbush (<i>Atriplex canescens</i>)	1.0	1.1
---	-----	-----

Paul Bunyan Burn (21A-19) and Paul Bunyan Burn and Chain (21A-20)

Aerial Mix

Species	Pounds of Seed	Pounds per acre
Hycrest crested wheatgrass (<i>Agropyron cristatum</i>)	15,100	4.0
Russian wildrye (<i>Elymus junceus</i>)	11,350	3.0
Elongated wheatgrass (<i>Agropyron elongatum</i>)	7,500	2.0

Dribbler Mix

Fourwing saltbush (<i>Atriplex canescens</i>)	3,800	1.0
---	-------	-----

Leamington Burn (21A-22) and Leamington Burn and Chain (21A-21)

Aerial Mix

Species	Pounds of seed	Pounds per acre
Hycrest crested wheatgrass (<i>Agropyron cristatum</i>)	12,450	3.3
Russian wildrye (<i>Elymus junceus</i>)	12,450	3.3
Elongated wheatgrass (<i>Agropyron elongatum</i>)	8,300	2.2
Great Basin wildrye (<i>Elymus cinereus</i>)	2,000	0.53
Smooth brome (<i>Bromus inermis</i>)	600	0.16
Alfalfa (<i>Medicago sativa</i>)	1,200	0.32
Small burnet (<i>Sanguisorba minor</i>)	500	0.13

Dribbler Mix

Fourwing saltbush (<i>Atriplex canescens</i>)	3,700	1.0
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Trend Study 21A-21-07

Study site name: Leamington Burn and Chain.

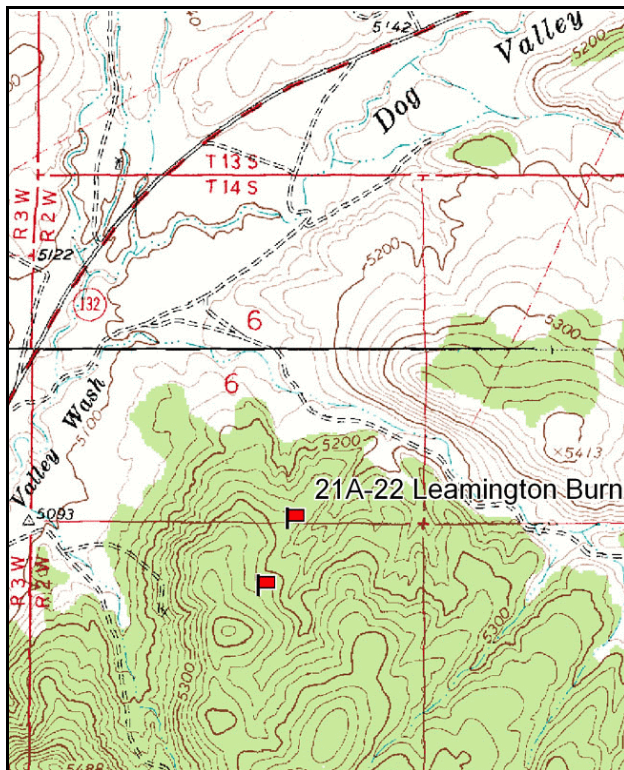
Vegetation type: Chained and Burned P-J.

Compass bearing: frequency baseline 322 degrees magnetic.

Frequency belt placement: line 1 (11ft), line 2 (34ft), line 3 (59ft), line 4 (71ft), line 5 (95ft). Rebar: belt 4 on 3ft.

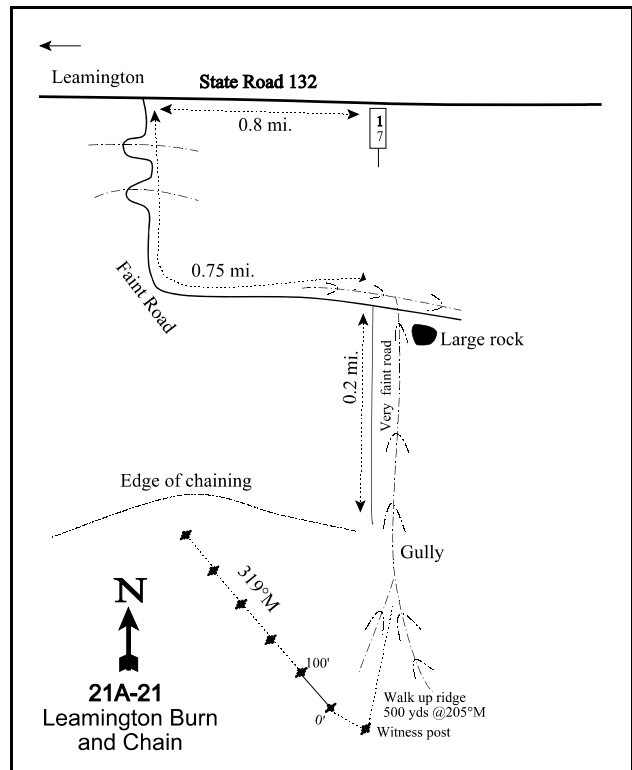
LOCATION DESCRIPTION

From Nephi, drive about 17.1 miles on State Road 132. Drive west 0.8 miles past mile marker 17 to a faint road on the left. Drive 0.75 miles past a water trough to a gully with a large boulder by the road. Go up the gully 0.2 miles to where it forks. Park here. From where the drainage divides in two, walk up the middle ridge about 500 yards at a bearing of 205 degrees magnetic to a witness post. The 0-foot stake is 20 feet from the witness post at about 319 degrees magnetic. The study is marked by 12-18 inch, green, steel fenceposts.



Map name: Sage Valley

Township 14S Range 2W Section 6



Diagrammatic Sketch

GPS: NAD 83, UTM 12S 404313 E 4385970 N

DISCUSSION

Leamington Burn and Chain - Trend Study No. 21A-21

Study Information

This study was established in 1997 to sample a burned, seeded, and chained area west of the Leamington Burn study (21A-22) [elevation: 5,300 feet (1,615 m), slope: 13%, aspect: northeast]. It is on BLM land approximately 17 miles (27.4 km) west of Nephi and 1 mile (1.6 km) south of SR-132. It was established to contrast secondary succession and establishment of seeded grasses and forbs with the nearby burned and seeded treatment that made no attempt to cover the seed. The area burned during the summer of 1996 and is part of the Leamington burn complex. Seed was applied aerially and the study was chained one-way with an Ely chain to cover the seed and enhance establishment of seeded species. Fourwing saltbush (*Atriplex canescens*) seed was also applied with a seed dribbler. Wildlife use has been limited in all sample years. Pellet group transect data indicated less than 1 deer day use/acre (2 ddu/ha) in 1997 and 2002, and 2 days use/acre (5 ddu/ha) in 2007. Elk use was estimated at 1 day use/acre (2 edu/ha) in 1997, 8 days use/acre (20 edu/ha) in 1998, 3 days use/acre (8 edu/ha) in 2002, and 2 days use/acre (5 edu/ha) in 2007. Cattle were grazing during the 2002 reading, and use was estimated at 9 days use/acre (21 cdu/ha) in 2002 and 14 days use/acre (34 cdu/ha) in 2007. Cattle use was much higher in the bottoms below the study.

Soil

The soil is classified as a Borvant-Reywat complex (USDA-NRCS 2007). Soils in the Borvant series are shallow over a petrocalcic horizon, and are well-drained. They formed in alluvium or colluvium derived from limestone and sandstone. Soils in the Reywat series are also shallow and well-drained, and formed in residuum and colluvium derived dominantly from andesite and basalt. The soil texture is a loam with a neutral reaction (pH 7.0). Rocks and pavement are abundant on the surface, and are also common throughout the soil profile. Relative combined rock and pavement cover decreased from 33% in 1997 to 23% in 2002 and 2007. Relative bare ground cover has decreased substantially, from 43% in 1997 to 27% in 2002 and 16% in 2007. Relative combined vegetation and litter cover increased from 21% in 1997 to 60% in 2007. The erosion condition was classified as stable in 2002 and 2007.

Browse

Browse is limited, with fourwing saltbush, Nevada ephedra (*Ephedra nevadensis*), antelope bitterbrush (*Purshia tridentata*), mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), and white rubber rabbitbrush (*Chrysothamnus nauseosus* ssp. *albicaulis*) occurring in low densities. Broom snakeweed (*Gutierrezia sarothrae*) is the most abundant browse species. Its density has ranged between 400 plants/acre (988 plants/ha) and 820 plants/acre (2,026 plants/ha) since 1997.

Herbaceous Understory

Herbaceous species, especially grasses, are dominant. Average perennial grass cover, which is composed mostly of seeded species, increased from 7% in 1997 to 19% in 1998, and ranged from 13% to 17% between 1999 and 2007. Crested wheatgrass (*Agropyron spicatum*) is the most abundant perennial grass, and has provided 24%-43% of the total grass cover since 1997. Other perennials include elongated wheatgrass (*Agropyron elongatum*), bluebunch wheatgrass (*Agropyron spicatum*), smooth brome (*Bromus inermis*), Russian wildrye (*Elymus junceus*), Indian ricegrass (*Oryzopsis hymenoides*), and Sandberg bluegrass (*Poa secunda*), although seeded species are more abundant than native species. In 1998, perennial grasses were noted as being vigorous and robust, with some reaching 3-4 feet (0.9-1.2 m) in height. In 2002, perennial grasses had been moderately utilized, with some of the large bunchgrasses used heavily. Use was light on grasses in 2007. Cheatgrass (*Bromus tectorum*) is also present. Its average cover increased from 1% in 1997 to 9%-10% in 1998 and 1999, then decreased to 5% in 2002 and 2007. Cheatgrass comprised 16% of the total grass cover in 1997, 42% in 1999, and 22% in 2007.

Forbs have been fairly diverse, but few species are abundant. Perennial forbs are rare. Alfalfa (*Medicago sativa*) and small burnet (*Sanguisorba minor*) were seeded, but quadrat frequency for each species has been less than 4% since 1997, and neither species was sampled in 2007. The sum of nested frequency for annual forbs increased substantially in 2007 and average cover increased from less than 1% in 2002 to 3% in 2007. The most abundant forbs in 2007 were desert alyssum (*Alyssum desertorum*), tansymustard (*Descurainia pinnata*), and bur buttercup (*Ranunculus testiculatus*), which is allelopathic (Buchanan et al. 1978). Musk thistle (*Carduus nutans*), a noxious weed, was sampled in 1997.

1998 TREND ASSESSMENT

The trend for browse is slightly up. No key browse species were sampled in 1997, but fourwing saltbush, ephedra, and bitterbrush were sampled in 1998 in very low densities. These plants were all young or mature and vigorous, and use was light. The trend for grass is up. The sum of nested frequency for perennial grasses increased 56% and average cover increased from 7% to 19%. Elongated wheatgrass increased significantly in nested frequency. However, cheatgrass also increased significantly in nested frequency and its average cover increased from 1% to 10%. The trend for forbs is slightly up. The sum of nested frequency for perennial forbs changed little, but average cover increased from 1% to 2%. The sum of nested frequency for annual forbs decreased almost 90%. Musk thistle was sampled in eight quadrats in 1997, but was not sampled in 1998. The Desirable Components Index (DCI) was rated as poor in 1997 due to low browse and perennial forb cover, and the presence of a noxious weed. The DCI rating improved to poor-fair in 1998 due to increased perennial grass and forb cover, and the lack of noxious weeds.

1997 winter range condition (DCI) - poor (14) Low potential scale

1998 winter range condition (DCI) - poor-fair (26) Low potential scale

browse - slightly up (+1)

grass - up (+2)

forb - slightly up (+1)

1999 TREND ASSESSMENT

The trend for browse is stable. Preferred browse densities remained very low. Fourwing saltbush displayed heavy use, while use on other species was light. The trend for grass is down. The sum of nested frequency for perennial grasses decreased 28%, while cover decreased from 19% to 13%. Cheatgrass did not change significantly in nested frequency or cover. The trend for forbs is stable. The sum of nested frequency for perennial forbs increased 12% and that for annual forbs increased 17%. However, total forb cover decreased from 2% to less than 1%. The DCI rating declined to poor due to decreases in perennial grass and forb cover.

winter range condition (DCI) - poor (20) Low potential scale

browse - stable (0)

grass - down (-2)

forb - stable (0)

2002 TREND ASSESSMENT

The trend for browse is stable. The preferred browse component remained very limited, and use on all species was light. The trend for grass is up. The sum of nested frequency for perennial grasses increased 38% and cover increased from 13% to 16%. Elongated wheatgrass, Russian wildrye, and Sandberg bluegrass increased significantly in nested frequency. Cheatgrass decreased significantly in nested frequency, and average cover decreased from 9% to 5%. The trend for forbs is down. The sum of nested frequency for perennial forbs decreased 81%, and total forb cover remained below 1%. The number of species sampled decreased from 12 to six. Small burnet was not sampled for the first time. The DCI rating improved to fair due to the increase in perennial grass cover and the decrease in cheatgrass cover.

winter range condition (DCI) - fair (27) Low potential scale

browse - stable (0)

grass - up (+2)

forb - down (-2)

2007 TREND ASSESSMENT

The trend for browse is stable. The preferred browse component remained unchanged. Bitterbrush showed

heavy hedging, while use was light on the other browse species. The trend for grass is stable. The sum of nested frequency for perennial grasses changed little. Elongated wheatgrass decreased significantly in nested frequency, while western wheatgrass (*Agropyron smithii*) increased significantly in nested frequency. The trend for forbs is stable. The number of forb species sampled increased from six to 11. The sum of nested frequency for perennial forbs changed little and cover remained below 1%. The sum of nested frequency for annual forbs increased significantly, and average annual cover increased from less than 1% to 3%. Alyssum and bur buttercup increased significantly in nested frequency. The DCI rating remained fair.

winter range condition (DCI) - fair (27) Low potential scale

browse - stable (0)

grass - stable (0)

forb - stable (0)

HERBACEOUS TRENDS --

Management unit 21A, Study no: 21

Type	Species	Nested Frequency					Average Cover %				
		'97	'98	'99	'02	'07	'97	'98	'99	'02	'07
G	<i>Agropyron cristatum</i>	_a 144	_a 152	_a 130	_a 132	_a 165	3.69	6.94	5.96	5.63	7.93
G	<i>Agropyron elongatum</i>	_a 39	_{bc} 96	_{ab} 74	_c 113	_{ab} 58	.98	4.71	2.33	4.30	2.62
G	<i>Agropyron smithii</i>	-	-	-	_a 5	_b 20	-	-	-	.03	.13
G	<i>Agropyron spicatum</i>	_a 27	_a 47	_a 31	_a 47	_a 47	1.25	3.46	2.72	3.67	3.35
G	<i>Bromus inermis</i>	_a 9	_{ab} 30	_{ab} 20	_b 39	_{ab} 16	.22	.73	.65	.24	.15
G	<i>Bromus japonicus</i> (a)	-	-	-	3	-	-	-	-	.03	-
G	<i>Bromus tectorum</i> (a)	_a 98	_{bc} 318	_c 351	_b 294	_{bc} 326	1.35	9.86	9.38	4.69	4.65
G	<i>Dactylis glomerata</i>	_a 18	_a 28	_a 10	-	-	.70	.65	.09	-	-
G	<i>Elymus junceus</i>	-	_{ab} 22	_a 3	_b 27	_b 36	-	.91	.15	.67	.69
G	<i>Oryzopsis hymenoides</i>	_a 26	_a 28	_a 25	_a 17	_a 21	.37	1.47	.95	.35	1.02
G	<i>Poa fendleriana</i>	_a 4	-	-	-	_a 1	.01	-	-	-	.03
G	<i>Poa secunda</i>	_a 4	_{ab} 19	_a 11	_{bc} 38	_c 46	.06	.58	.05	.61	.58
G	<i>Stipa comata</i>	-	-	-	-	3	-	-	-	-	.03
G	<i>Vulpia octoflora</i> (a)	-	-	-	-	1	-	-	-	-	.00
Total for Annual Grasses		98	318	351	297	327	1.35	9.86	9.38	4.73	4.66
Total for Perennial Grasses		271	422	304	418	413	7.30	19.46	12.91	15.55	16.56
Total for Grasses		369	740	655	715	740	8.66	29.33	22.29	20.28	21.22
F	<i>Alyssum desertorum</i> (a)	-	_a 2	_a 4	_a 10	_b 253	-	.00	.00	.03	1.39
F	<i>Astragalus beckwithii</i>	_a 3	-	-	_a 5	-	.00	-	-	.04	-
F	<i>Astragalus calycosus</i>	_a 12	_a 7	_a 14	_a 1	-	.12	.09	.07	.00	-
F	<i>Astragalus</i> sp.	_a 6	_a 6	_a 3	-	_a 8	.18	.19	.03	-	.07
F	<i>Camelina microcarpa</i> (a)	-	_a 2	-	-	_a 1	-	.03	-	-	.00
F	<i>Carduus nutans</i> (a)	16	-	-	-	-	.04	-	-	-	-
F	<i>Calochortus nuttallii</i>	_a -	-	-	-	_a 1	.00	-	-	-	.00
F	<i>Chaenactis douglasii</i>	_a 10	_a 10	-	-	-	.32	.24	-	-	-
F	<i>Cryptantha</i> sp.	_a 1	-	-	-	_a 1	.00	-	-	-	.00

T y p e	Species	Nested Frequency					Average Cover %				
		'97	'98	'99	'02	'07	'97	'98	'99	'02	'07
F	Descurainia pinnata (a)	_{ab} 15	_a 1	-	-	_b 32	.10	.02	-	-	1.00
F	Draba sp. (a)	-	_a 1	_a 1	-	_a 5	-	.00	.00	-	.01
F	Gilia sp. (a)	23	-	-	-	-	.92	-	-	-	-
F	Lactuca serriola	-	_a 15	_a 30	-	-	-	.38	.53	-	-
F	Lesquerella sp.	_a 5	_a 4	-	-	-	.01	.16	-	-	-
F	Medicago sativa	_a 1	_a 4	_a 1	_a 1	-	.11	.29	.01	.03	-
F	Nicotiana attenuata (a)	1	-	-	-	-	.00	-	-	-	-
F	Phlox hoodii	-	_a 1	_a 1	_a 4	_a 3	-	.00	.00	.18	.15
F	Phlox longifolia	_a 4	-	_a 3	-	-	.01	-	.00	-	-
F	Ranunculus testiculatus (a)	_a 7	-	-	_b 52	_c 196	.02	-	-	.24	.84
F	Salsola iberica (a)	-	-	1	-	-	-	-	.00	-	-
F	Sanguisorba minor	_a 2	_a 3	_a 2	-	-	.15	.18	.03	-	-
F	Senecio multilobatus	-	2	-	-	-	-	.03	-	-	-
F	Sisymbrium altissimum (a)	-	-	_a 1	-	_a 5	-	-	.03	-	.06
F	Streptanthus cordatus	_a 8	-	-	-	_a 7	.02	-	-	-	.01
F	Tragopogon dubius	-	-	4	-	-	-	-	.00	-	-
Total for Annual Forbs		62	6	7	62	492	1.09	0.05	0.04	0.27	3.31
Total for Perennial Forbs		52	52	58	11	20	0.95	1.57	0.69	0.25	0.24
Total for Forbs		114	58	65	73	512	2.05	1.63	0.74	0.52	3.55

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 21A, Study no: 21

T y p e	Species	Strip Frequency					Average Cover %				
		'97	'98	'99	'02	'07	'97	'98	'99	'02	'07
B	Atriplex canescens	0	1	1	1	1	.03	-	-	.15	.00
B	Chrysothamnus nauseosus albicaulis	0	0	0	0	1	-	-	-	-	.15
B	Chrysothamnus viscidiflorus viscidiflorus	0	1	0	0	0	-	-	-	-	-
B	Ephedra nevadensis	0	1	0	1	0	-	-	-	.00	-
B	Gutierrezia sarothrae	16	11	22	19	13	.07	.59	.52	.31	.19
B	Purshia tridentata	0	1	1	0	1	-	-	-	-	-
Total for Browse		16	15	24	21	16	0.10	0.59	0.52	0.46	0.35

CANOPY COVER, LINE INTERCEPT --

Management unit 21A, Study no: 21

Species	Percent Cover	
	'02	'07
<i>Atriplex canescens</i>	-	.06
<i>Gutierrezia sarothrae</i>	-	.11

BASIC COVER --

Management unit 21A, Study no: 21

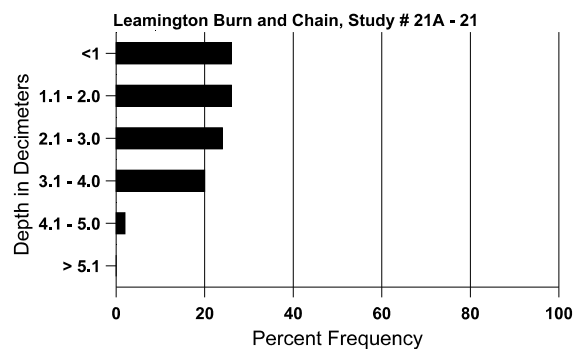
Cover Type	Average Cover %				
	'97	'98	'99	'02	'07
Vegetation	10.43	34.11	25.44	24.21	27.25
Rock	16.54	20.72	15.36	20.31	17.49
Pavement	13.43	10.18	3.30	5.80	7.74
Litter	9.42	27.58	21.86	30.73	36.31
Cryptogams	1.96	0	0	.01	.19
Bare Ground	39.39	27.02	21.77	29.36	17.11

SOIL ANALYSIS DATA --

Herd Unit 21A, Study no: 21, Leamington Burn and Chain

Effective rooting depth (in)	Temp °F (depth)	pH	Loam			%OM	ppm P	ppm K	dS/m
			%sand	%silt	%clay				
13.8	62.8 (14.4)	7.0	46.0	33.1	20.9	3.0	12.3	195.2	.9

Stoniness Index



PELLET GROUP DATA --

Management unit 21A, Study no: 21

Type	Quadrat Frequency				
	'97	'98	'99	'02	'07
Rabbit	2	3	11	5	66
Elk	1	4	2	-	3
Deer	3	-	1	2	2
Cattle	-	-	4	2	1

Days use per acre (ha)	
'02	'07
-	-
3 (8)	2 (5)
1 (2)	2 (5)
9 (21)	14 (34)

BROWSE CHARACTERISTICS --

Management unit 21A, Study no: 21

		Age class distribution (plants per acre)					Utilization					
Y	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
<i>Artemisia tridentata</i> vaseyana												
97	0	-	-	-	-	-	0	0	-	-	0	-/-
98	0	-	-	-	-	-	0	0	-	-	0	-/-
99	0	-	-	-	-	-	0	0	-	-	0	-/-
02	0	-	-	-	-	-	0	0	-	-	0	17/24
07	0	-	-	-	-	-	0	0	-	-	0	36/45
<i>Atriplex canescens</i>												
97	0	20	-	-	-	-	0	0	-	-	0	-/-
98	20	-	-	20	-	-	0	0	-	-	0	34/41
99	20	-	-	20	-	-	0	100	-	-	0	31/28
02	20	-	-	20	-	-	0	0	-	-	0	26/30
07	20	-	-	20	-	-	0	0	-	-	0	56/67
<i>Chrysothamnus nauseosus albicaulis</i>												
97	0	-	-	-	-	-	0	0	0	-	0	-/-
98	0	-	-	-	-	-	0	0	0	-	0	23/20
99	0	-	-	-	-	-	0	0	0	-	0	27/26
02	0	-	-	-	-	-	0	0	0	-	0	12/12
07	20	-	-	-	20	-	0	0	100	-	0	36/50
<i>Chrysothamnus viscidiflorus viscidiflorus</i>												
97	0	-	-	-	-	-	0	0	-	-	0	-/-
98	20	-	20	-	-	-	0	0	-	-	100	-/-
99	0	-	-	-	-	-	0	0	-	-	0	18/31
02	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	10/17

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
Ephedra nevadensis												
97	0	-	-	-	-	-	0	0	-	-	0	-/-
98	20	-	20	-	-	-	0	0	-	-	0	16/22
99	0	-	-	-	-	-	0	0	-	-	0	11/28
02	20	-	-	20	-	-	0	0	-	-	0	19/28
07	0	-	-	-	-	-	0	0	-	-	0	20/35
Gutierrezia sarothrae												
97	500	-	-	500	-	-	0	0	0	-	0	-/-
98	400	20	-	400	-	-	0	0	0	-	0	12/18
99	820	20	100	720	-	-	0	0	0	-	0	11/16
02	680	-	40	540	100	40	0	0	15	12	12	6/10
07	480	160	100	280	100	40	0	0	21	13	17	10/16
Juniperus osteosperma												
97	0	-	-	-	-	-	0	0	-	-	0	-/-
98	0	-	-	-	-	-	0	0	-	-	0	-/-
99	0	-	-	-	-	60	0	0	-	-	0	-/-
02	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	-/-
Leptodactylon pungens												
97	0	-	-	-	-	-	0	0	-	-	0	-/-
98	0	-	-	-	-	-	0	0	-	-	0	-/-
99	0	-	-	-	-	-	0	0	-	-	0	-/-
02	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	7/12
Purshia tridentata												
97	0	-	-	-	-	-	0	0	-	-	0	-/-
98	20	-	20	-	-	-	0	0	-	-	0	-/-
99	20	-	20	-	-	-	0	0	-	-	0	-/-
02	0	-	-	-	-	-	0	0	-	-	0	-/-
07	20	-	-	20	-	-	0	100	-	-	0	12/24

Trend Study 21A-22-07

Study site name: Leamington Burn.

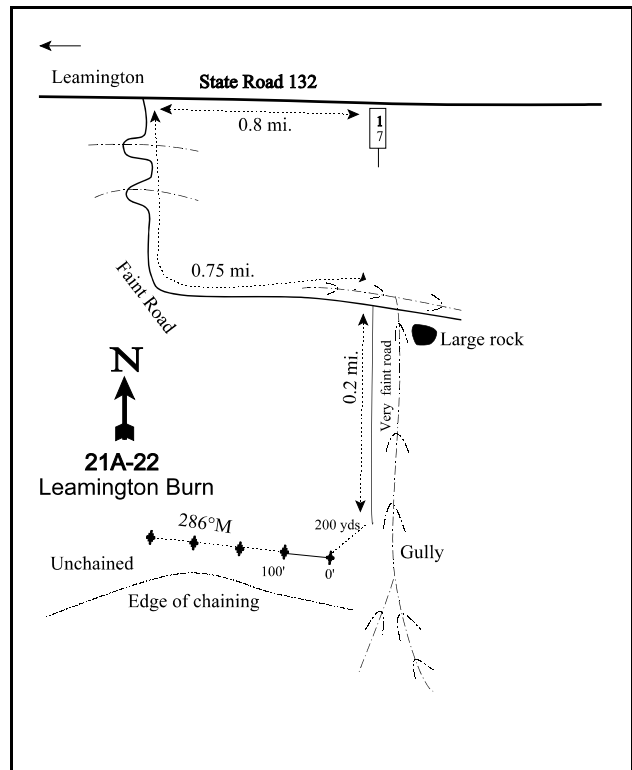
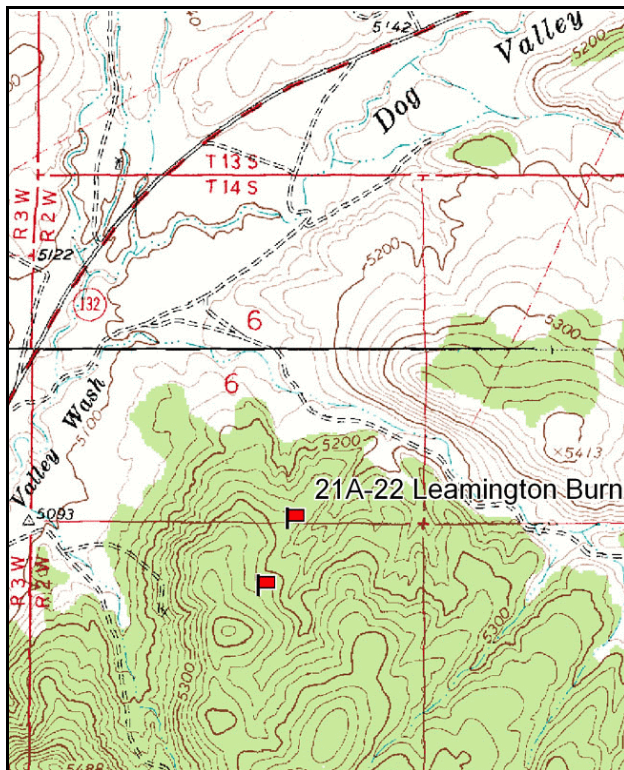
Vegetation type: Burned Pinyon-Juniper.

Compass bearing: frequency baseline 286 degrees magnetic.

Frequency belt placement: line 1 (11 & 95ft), line 2 (34ft), line 3 (59ft), line 4 (71ft). Rebar: belt 4 on 1ft.

LOCATION DESCRIPTION

From Nephi, drive about 17.1 miles on State Road 132. Drive west 0.8 miles past mile marker 17 to a faint road on the left. Drive 0.75 miles past a water trough to a gully with a large boulder by the road. Go up the gully 0.2 miles to where it forks. Park here. The study is located on the ridge west of the gully. From the fork, the study is 200 yards away by the edge of the chaining. The study is marked by 12-18 inch, green, steel fenceposts.



Map Name: Sage Valley.

Diagrammatic Sketch

Township 14S Range 2W Section 6

GPS: NAD 83, UTM 12S 404409 E 4386173 N

DISCUSSION

Leamington Burn - Trend Study No. 21A-22

Study Information

This study was established in 1997 on a burned and seeded pinyon-juniper woodland [elevation: 5,300 feet (1,615 m), slope: 8%, aspect: northeast]. It is on BLM land approximately 17 miles (27.4 km) west of Nephi and 1 mile (1.6 km) south of SR-132. It is part of the extensive Leamington burn complex that took place during the summer of 1996. The area was aerially seeded, but not chained. The paired site, Leamington Burn and Chain (Study 21A-21), samples a burned area that was aerially seeded, then chained. The purpose of these paired studies is to contrast the difference in seeded species establishment and recovery between the treatments. Wildlife use has been very light. Deer use was estimated at less than 1 day use/acre (2 ddu/ha) in 2002 and 3 days use/acre (8 ddu/ha) in 2007. Elk use was estimated at 5 days use/acre (12 edu/ha) in 1998 and 1 day use/acre (3 edu/ha) in 2002 and 2007. Livestock were present during the 2002 reading. Cattle use was estimated at 13 days use/acre (32 cdu/ha) in 2002 and 16 days use/acre (39 cdu/ha) in 2007. The cattle pats in 2007 were from the previous year.

Soil

The soil is classified as a Borvant-Reywat complex (USDA-NRCS 2007). Soils in the Borvant series are shallow over a petrocalcic horizon, and are well-drained. They formed in alluvium or colluvium derived from limestone and sandstone. Soils in the Reywat series are also shallow and well-drained, and formed in residuum and colluvium derived dominantly from andesite and basalt. The soil texture is a loam with a neutral reaction (pH 7.0). Soil phosphorus is marginal at 8 ppm (Tiedemann and Lopez 2004). Rocks are common on the surface and within the profile, and some of the rocks beneath the soil surface have calcium carbonate deposits. The soil surface was described as hard in 2007. Relative bare ground cover increased from 16% in 1999 to 41% in 2002, then decreased to 25% by 2007. Although there is a considerable percentage of bare soil cover, erosion is minimal. The erosion condition was classified as stable in 2002 and 2007.

Browse

Prior to the fire, the dominant vegetation consisted of Utah juniper (*Juniperus osteosperma*) and pinyon pine (*Pinus edulis*). Shrubs have been rare since the study burned. A group of unburned juniper trees intermixed with Wyoming big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) remains at the end of the baseline, where the majority of the pellet groups were sampled. The sagebrush population was tall and unused in 2007, and density is very low at only 20 plants/acre (49 plants/ha). Nevada ephedra (*Ephedra nevadensis*) and fourwing saltbush (*Atriplex canescens*) also occur in low densities. Sprouting species, such as white rubber rabbitbrush (*Chrysothamnus nauseosus* ssp. *albicaulis*), stickyleaf low rabbitbrush (*Chrysothamnus viscidiflorus* ssp. *viscidiflorus*), and broom snakeweed (*Gutierrezia sarothrae*) have been sampled at higher densities.

Herbaceous Understory

The majority of vegetative cover is provided by the herbaceous understory, mainly grasses. Total grass cover increased dramatically from 7% in 1997 to 37% in 1998, decreased to 16% in 2002, and increased to 21% in 2007. However, cheatgrass (*Bromus tectorum*) provided the large majority of the grass cover in 1998 and 1999 at 26% and 20% cover, respectively. Average cheatgrass cover declined to 5% in 2002 and 4% in 2007, while seeded and native perennial grasses steadily increased in cover. Average perennial grass cover was 5% in 1997, 11% in 1998, 10% in 1999, 11% in 2002, and 17% in 2007. Common species include crested wheatgrass (*Agropyron cristatum*), bluebunch wheatgrass (*Agropyron spicatum*), Sandberg bluegrass (*Poa secunda*), and Indian ricegrass (*Oryzopsis hymenoides*). Elongated wheatgrass (*Agropyron elongatum*), Russian wildrye (*Elymus junceus*), smooth brome (*Bromus inermis*), and bottlebrush squirreltail (*Sitanion hystrix*) are also present in low frequencies.

The forb component was diverse in 1997 and 1998 with 16 and 15 species sampled, respectively, but declined to nine species sampled in 2002 and 11 species sampled in 2007. In 1997, approximately half of the total forb cover was provided by perennial species, but annuals were largely dominant in 2002 and 2007. The most common species were bur buttercup (*Ranunculus testiculatus*), an allelopathic annual (Buchanan et al. 1978), and desert Alyssum (*Alyssum desertorum*). Additionally, knapweed (*Centaurea* sp.) and musk thistle (*Carduus nutans*), both noxious species, were sampled in 1998 and 2002, respectively.

1998 TREND ASSESSMENT

The trend for browse is stable. No preferred browse species were sampled, which is a slight decrease from three Ephedra plants being sampled in 1997. The trend for grass is slightly down. The sum of nested frequency for perennial grasses remained stable, while cheatgrass increased significantly in nested frequency. Cheatgrass quadrat frequency increased from 54% to 99%, and average cover increased from 2% to 26%. Crested wheatgrass also increased significantly in nested frequency, however, the increase was not as substantial as that of cheatgrass. The trend for forbs is down. The sum of nested frequency for perennial forbs decreased almost 50%. Longleaf phlox (*Phlox longifolia*) decreased significantly in nested frequency. Knapweed was sampled at a quadrat frequency of 5%. The Desirable Components Index (DCI) was rated as poor in 1997 due to the lack of browse and relatively low perennial grass and forb cover. The DCI rating decreased to very poor in 1998 due to the increase in cheatgrass cover and the presence of a noxious weed.

1997 winter range condition (DCI) - poor (13) Low potential scale

1998 winter range condition (DCI) - very poor (4) Low potential scale

browse - stable (0)

grass - slightly down (-1)

forb - down (-2)

1999 TREND ASSESSMENT

The trend for browse is stable. The shrub component remained depleted, although Ephedra density increased from 0 plants/acre to 40 plants/acre (99 plants/ha). The trend for grass is down. The sum of nested frequency for perennial grasses decreased 28%, while that for cheatgrass increased 6%. Cheatgrass quadrat frequency remained high at 97%, while its cover declined from 26% to 20%. Sandberg bluegrass decreased significantly in nested frequency. The trend for forbs is slightly down. The sum of nested frequency for perennial forbs decreased 32%. Douglas chaenactis (*Chaenactis douglasii*) decreased significantly in nested frequency, while prickly lettuce (*Lactuca serriola*) increased significantly in nested frequency. Knapweed was not sampled. The DCI rating remained very poor.

winter range condition (DCI) - very poor (6) Low potential scale

browse - stable (0)

grass - down (-2)

forb - slightly down (-1)

2002 TREND ASSESSMENT

The trend for browse is stable. Ephedra density increased from 40 plants/acre (99 plants/ha) to 60 plants/acre (148 plants/ha), and was moderately hedged. Sagebrush was also sampled at a density of 20 plants/acre (49 plants/ha). The trend for grass is up. The sum of nested frequency for perennial grasses increased two-fold. Crested wheatgrass and Sandberg bluegrass increased significantly in nested frequency. Cheatgrass decreased significantly in nested frequency, and its average cover decreased from 20% to 5%. However, cheatgrass quadrat frequency remained high at 96%. The trend for forbs is down. The sum of nested frequency for perennial forbs decreased 47%, while that for annuals increased substantially. Bur buttercup and Alyssum both increased significantly in nested frequency. Annual forb cover increased from less than 1% to 3%. Musk thistle was sampled, but only in one quadrat. The DCI rating increased to poor due to the increase in perennial grass cover and the decrease in annual grass cover.

winter range condition (DCI) - poor (18) Low potential scale

browse - stable (0)

grass - up (+2)

forb - down (-2)

2007 TREND ASSESSMENT

The trend for browse is stable. Sagebrush density remained stable, and ephedra density declined slightly from 60 plants/acre (148 plants/ha) to 20 plants/acre (49 plants/ha). The trend for grass is up. The sum of nested frequency for perennial grasses increased almost 30% and cover increased from 11% to 17%. Sandberg bluegrass increased significantly in nested frequency. Average cheatgrass cover continued to decrease from 5% to 4%. However, cheatgrass nested frequency and quadrat frequency remained stable. The trend for forbs is stable. The sum of nested frequency for perennial forbs did not change, however, bur buttercup, which may inhibit the germination of other species (Buchanan et al. 1978), increased significantly in nested frequency. Alyssum also increased significantly in nested frequency. No noxious weeds were sampled. The DCI rating improved to fair due to the increase in perennial grass cover and the absence of noxious weeds.

winter range condition (DCI) - fair (27) Low potential scale

browse - stable (0)

grass - up (+2)

forb - stable (0)

HERBACEOUS TRENDS --

Management unit 21A, Study no: 22

T y p e	Species	Nested Frequency					Average Cover %				
		'97	'98	'99	'02	'07	'97	'98	'99	'02	'07
G	Agropyron cristatum	_a 6	_b 35	_b 36	_c 82	_c 108	.27	1.50	1.63	3.56	6.34
G	Agropyron elongatum	-	_a 3	_a 4	_a 11	_a 15	-	.04	.18	.36	.42
G	Agropyron spicatum	_a 60	_a 41	_a 46	_a 65	_a 59	2.20	3.90	5.94	4.08	4.28
G	Bromus inermis	-	-	_a 1	_a 4	_a 3	-	-	.03	.01	.06
G	Bromus japonicus (a)	-	-	-	_a 4	_a 14	-	-	-	.03	.02
G	Bromus tectorum (a)	_a 153	_c 430	_c 454	_b 340	_b 345	2.34	26.01	20.14	4.54	4.30
G	Elymus junceus	-	_{ab} 4	_a 1	_{ab} 6	_b 11	-	.03	.03	.16	.37
G	Oryzopsis hymenoides	_a 68	_a 58	_a 49	_a 39	_a 45	1.26	3.06	1.54	1.44	1.57
G	Poa secunda	_b 63	_b 54	_a 7	_c 110	_d 183	.87	1.22	.04	1.51	3.80
G	Sitanion hystrix	_b 16	_{ab} 22	_{ab} 12	_{ab} 7	_a 2	.17	.78	.18	.04	.00
G	Stipa comata	-	-	-	7	-	-	-	-	.03	-
Total for Annual Grasses		153	430	454	344	359	2.34	26.01	20.14	4.57	4.32
Total for Perennial Grasses		213	217	156	331	426	4.78	10.55	9.60	11.22	16.86
Total for Grasses		366	647	610	675	785	7.13	36.57	29.75	15.80	21.19
F	Alyssum desertorum (a)	_a 1	_a 2	_a 3	_b 81	_c 272	.00	.00	.00	.14	1.24
F	Arabis sp.	_a 3	-	_a 3	-	-	.00	-	.07	-	-
F	Astragalus beckwithii	_a 4	_a -	-	-	-	.06	.00	-	-	-
F	Camelina microcarpa (a)	-	_a 6	_a 3	_a 16	_a 3	-	.06	.03	.22	.03
F	Carduus nutans (a)	-	-	-	2	-	-	-	-	.00	-
F	Calochortus nuttallii	_a 3	-	_a -	_a 1	_a 1	.01	-	.00	.00	.00
F	Centaurea sp.	-	7	-	-	-	-	.05	-	-	-
F	Chaenactis douglasii	_b 52	_b 42	_a 2	_a 8	-	.97	1.20	.00	.01	-
F	Chorispora tenella (a)	-	-	-	-	5	-	-	-	-	.03

T y p e	Species	Nested Frequency					Average Cover %				
		'97	'98	'99	'02	'07	'97	'98	'99	'02	'07
F	<i>Crepis acuminata</i>	-	-	-	-	-	-	.03	-	-	-
F	<i>Descurainia pinnata</i> (a)	_b 14	-	_{ab} 6	_a 4	_{ab} 16	.13	-	.18	.00	.03
F	<i>Draba</i> sp. (a)	-	_a 14	-	-	_a 14	-	.02	-	-	.02
F	<i>Eriogonum cernuum</i> (a)	_a 6	_a 3	-	-	-	.30	.03	-	-	-
F	<i>Erigeron</i> sp.	-	3	-	-	-	-	.03	-	-	-
F	<i>Gilia</i> sp. (a)	77	-	-	-	-	1.64	-	-	-	-
F	<i>Holosteum umbellatum</i> (a)	-	-	-	-	15	-	-	-	-	.09
F	<i>Lactuca serriola</i>	_a 6	_a 17	_b 45	-	-	.61	.49	.37	-	-
F	<i>Lesquerella</i> sp.	38	-	-	-	-	.19	-	-	-	-
F	<i>Medicago sativa</i>	_a 1	_a 4	_a 3	-	-	.00	.18	.04	-	-
F	<i>Nicotiana attenuata</i> (a)	-	2	-	-	-	-	.00	-	-	-
F	<i>Phlox longifolia</i>	_b 46	_a 13	-	_a 17	_a 28	.36	.03	-	.06	.06
F	<i>Ranunculus testiculatus</i> (a)	_b 112	_a 3	_a 5	_c 271	_d 371	.76	.03	.01	2.91	2.11
F	<i>Salsola iberica</i> (a)	-	_a -	_a 5	_a -	-	-	.15	.18	.00	-
F	<i>Sanguisorba minor</i>	_a 1	_a 2	-	-	-	.15	.15	-	-	-
F	<i>Sisymbrium altissimum</i> (a)	-	_a 1	_a 8	-	_b 21	-	.15	.18	-	.55
F	<i>Streptanthus cordatus</i>	7	-	-	-	-	.04	-	-	-	-
F	<i>Tragopogon dubius</i>	_a 3	_a 3	_a 4	_a 4	_a 1	.03	.10	.05	.00	.00
Total for Annual Forbs		210	31	30	374	717	2.84	0.46	0.60	3.29	4.12
Total for Perennial Forbs		164	91	57	30	30	2.44	2.28	0.53	0.09	0.07
Total for Forbs		374	122	87	404	747	5.28	2.74	1.13	3.38	4.19

Values with different subscript letters are significantly different at alpha = 0.10

BROWSE TRENDS --

Management unit 21A, Study no: 22

Type	Species	Strip Frequency					Average Cover %				
		'97	'98	'99	'02	'07	'97	'98	'99	'02	'07
B	Artemisia tridentata vaseyana	0	0	0	1	1	-	-	-	.15	.00
B	Chrysothamnus nauseosus	0	0	0	0	16	-	-	-	-	1.20
B	Chrysothamnus nauseosus albicaulis	0	1	3	4	8	.00	-	.38	.38	.03
B	Chrysothamnus viscidiflorus viscidiflorus	0	1	1	1	2	.03	.15	.00	-	.15
B	Ephedra nevadensis	1	0	1	1	1	-	-	-	.00	.15
B	Gutierrezia sarothrae	2	8	15	13	14	.18	.86	1.03	.65	.61
B	Leptodactylon pungens	0	0	4	9	8	.00	-	-	.06	-
Total for Browse		3	10	24	29	50	0.22	1.00	1.42	1.25	2.15

CANOPY COVER, LINE INTERCEPT --

Management unit 21A, Study no: 22

Species	Percent Cover	
	'02	'07
Chrysothamnus nauseosus	-	2.33
Ephedra nevadensis	-	.55
Gutierrezia sarothrae	-	.30

BASIC COVER --

Management unit 21A, Study no: 22

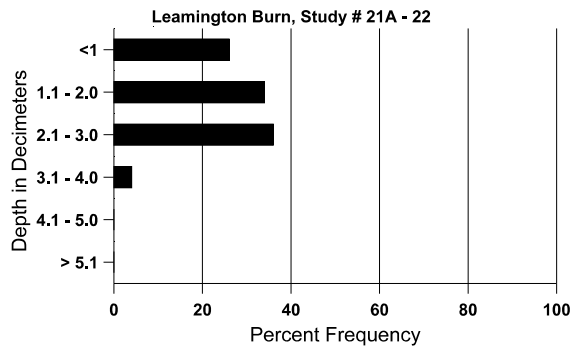
Cover Type	Average Cover %				
	'97	'98	'99	'02	'07
Vegetation	13.11	39.16	35.04	22.46	30.36
Rock	11.08	9.00	6.96	7.53	7.05
Pavement	20.50	12.50	5.31	6.49	10.67
Litter	7.05	28.25	39.20	27.58	33.95
Cryptogams	2.08	.19	.06	.22	.24
Bare Ground	32.10	28.43	16.73	44.74	26.81

SOIL ANALYSIS DATA --

Herd Unit 21A, Study no: 22, Leamington Burn

Effective rooting depth (in)	Temp °F (depth)	pH	Loam			%0M	ppm P	ppm K	dS/m
			%sand	%silt	%clay				
13.7	62.0 (13.5)	7.0	46.7	28.4	24.8	2.4	8.0	214.4	.6

Stoniness Index



PELLET GROUP DATA --

Management unit 21A, Study no: 22

Type	Quadrat Frequency				
	'97	'98	'99	'02	'07
Rabbit	15	1	24	14	70
Elk	-	1	4	-	1
Deer	1	1	1	1	2
Cattle	1	-	2	5	7

Days use per acre (ha)	
'02	'07
-	-
1 (3)	1 (3)
1 (2)	3 (8)
13 (32)	16 (40)

BROWSE CHARACTERISTICS --

Management unit 21A, Study no: 22

		Age class distribution (plants per acre)					Utilization					
Y	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
Artemisia tridentata vaseyana												
97	0	-	-	-	-	80	0	0	-	-	0	-/-
98	0	-	-	-	-	-	0	0	-	-	0	-/-
99	0	-	-	-	-	80	0	0	-	-	0	11/9
02	20	-	-	20	-	-	0	0	-	-	0	9/11
07	20	-	-	20	-	-	0	0	-	-	0	23/32
Atriplex canescens												
97	0	-	-	-	-	-	0	0	-	-	0	-/-
98	0	-	-	-	-	-	0	0	-	-	0	-/-
99	0	-	-	-	-	-	0	0	-	-	0	46/33
02	0	-	-	-	-	-	0	0	-	-	0	24/32
07	0	-	-	-	-	-	0	0	-	-	0	42/46

		Age class distribution (plants per acre)					Utilization					
Y e a r	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
Chrysothamnus nauseosus												
97	0	-	-	-	-	-	0	0	0	-	0	-/-
98	0	-	-	-	-	-	0	0	0	-	0	-/-
99	0	-	-	-	-	-	0	0	0	-	0	-/-
02	0	-	-	-	-	-	0	0	0	-	0	-/-
07	940	60	100	800	40	20	6	0	4	-	2	24/29
Chrysothamnus nauseosus albicaulis												
97	0	-	-	-	-	-	0	0	0	-	0	-/-
98	20	-	20	-	-	-	0	0	0	-	0	-/-
99	60	-	-	60	-	-	0	0	0	-	0	27/27
02	100	-	20	80	-	-	20	20	0	-	0	30/38
07	380	-	20	340	20	-	5	0	5	-	0	12/11
Chrysothamnus viscidiflorus viscidiflorus												
97	0	-	-	-	-	-	0	0	0	-	0	-/-
98	20	-	-	20	-	-	0	0	0	-	0	-/-
99	40	-	-	40	-	-	0	0	0	-	0	13/18
02	40	-	-	40	-	-	0	0	0	-	0	13/18
07	40	-	-	20	20	-	0	0	50	50	50	13/31
Ephedra nevadensis												
97	60	-	60	-	-	-	0	0	-	-	0	-/-
98	0	-	-	-	-	-	0	0	-	-	0	-/-
99	40	-	-	40	-	-	0	0	-	-	0	19/34
02	60	-	-	60	-	-	100	0	-	-	0	21/38
07	20	-	-	20	-	-	0	0	-	-	0	27/47
Gutierrezia sarothrae												
97	80	-	20	60	-	-	0	0	0	-	0	7/3
98	240	20	-	240	-	-	0	0	0	-	0	12/20
99	520	-	20	500	-	-	0	0	0	-	0	12/20
02	360	-	-	280	80	80	0	0	22	11	11	7/13
07	320	260	60	260	-	-	6	0	0	-	6	10/16
Juniperus osteosperma												
97	0	-	-	-	-	40	0	0	-	-	0	-/-
98	0	-	-	-	-	20	0	0	-	-	0	-/-
99	0	-	-	-	-	80	0	0	-	-	0	-/-
02	0	-	-	-	-	-	0	0	-	-	0	-/-
07	0	-	-	-	-	-	0	0	-	-	0	-/-

		Age class distribution (plants per acre)					Utilization					
Year	Plants per Acre (excluding seedlings)	Seedling	Young	Mature	Decadent	Dead	% moderate	% heavy	% decadent	% dying	% poor vigor	Average Height Crown (in)
Leptodactylon pungens												
97	0	-	-	-	-	-	0	0	0	-	0	-/-
98	0	-	-	-	-	-	0	0	0	-	0	-/-
99	80	-	40	40	-	-	0	0	0	-	0	3/6
02	260	-	-	260	-	-	0	0	0	-	0	5/10
07	180	-	-	160	20	-	0	0	11	-	0	6/14

Summary and Comparison between Leamington Burn and Chain (21A-21)
and Leamington Burn (21A-22)

Studies 21A-21 and 21A-22 were established in 1997 to monitor the recovery of the vegetation community on two treatments following the Leamington wildfire complex that burned in 1996. These studies were paired to compare differences in restoration efforts between seeding only (21A-22) and seeding followed by one-way chaining (21A-21) to cover the seed and enhance establishment of the seeded species. Both of these studies were seeded with the same mix.

As with the previous fire rehabilitation studies, the herbaceous understory, primarily the grass component, dominates the vegetation community at the Leamington sites. Perennial grasses established more quickly on the chained study, and were higher in average cover and nested frequency from 1997-2002 (Figures 1 and 2). In 1998, perennial grass cover and nested frequency on the chained study were almost double that on the unchained study. By 2007, average cover and nested frequency were similar for the two studies.

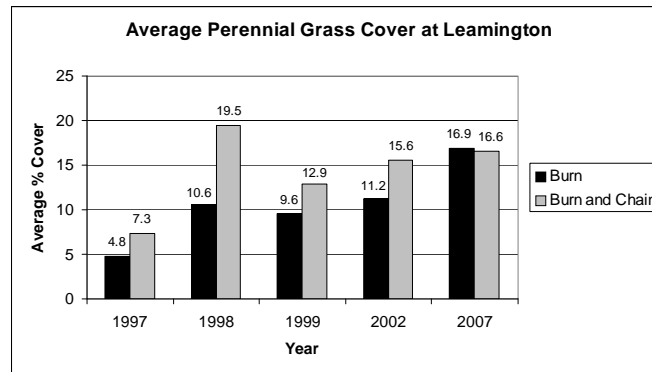


Figure 1. Average perennial grass cover on the Leamington fire rehabilitation studies, 1997-2007.

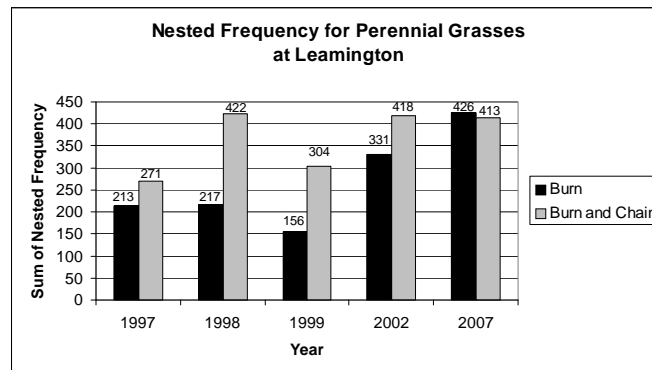


Figure 2. Nested frequency for perennial grasses on the Leamington fire rehabilitation studies, 1997-2007.

Average cheatgrass (*Bromus tectorum*) cover was lower on the chained study in 1997-1999, but was similar to the unchained study in 2002 and 2007 (Figures 3 and 4). Cheatgrass cover on the unchained study was more than double that on the chained study in 1998 and 1999. The nested frequency of cheatgrass was greater on the unchained study in all sample years.

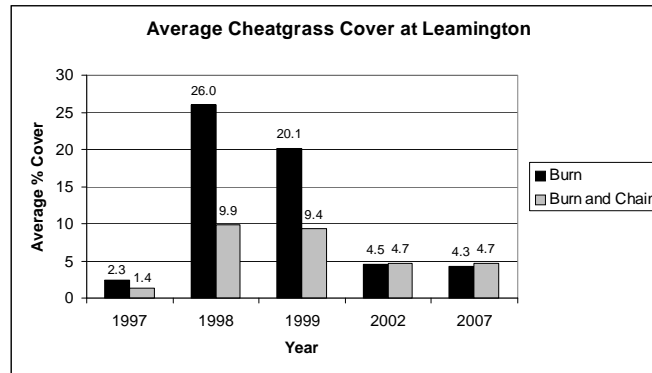


Figure 3. Average cheatgrass cover on the Leamington fire rehabilitation studies, 1997-2007.

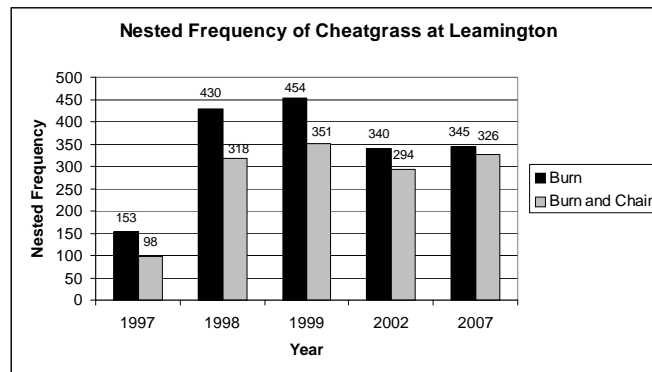


Figure 4. Nested frequency of cheatgrass on the Leamington fire rehabilitation studies, 1997-2007.

Although both studies have a limited and poor forb component, average cover and sum of nested frequency for perennial forbs were slightly greater on the unchained study in 1997 and 1998, and were similar for both studies in 1999, 2002, and 2007. Alfalfa (*Medicago sativa*) and small burnet (*Sanguisorba minor*) were seeded on both studies, but quadrat frequencies were less than 4% for each species in 1997-2002, and neither species was sampled in 2007. The browse component is also very sparse. Fourwing saltbush (*Atriplex canescens*) was seeded, but provided little cover.

The best way to control cheatgrass competition is to establish a healthy and abundant perennial understory (Monsen 1994). Chaining following a seeding provides cover for germinating seeds, and allows them to establish more readily. The comparison between the Leamington studies illustrates this point. Preparation of the seedbed allowed perennial grasses to establish quickly, which minimized the spread of cheatgrass. On average, seeded grass species also had higher quadrat frequencies and cover values on the chained study, indicating that the seedbed preparation allowed more widespread establishment.